January 27, 2020

VIA IBFS

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: ***Written Ex Parte Presentation***
IBFS File No. SAT-LOA-20190704-00057; Call Sign S3051

Dear Ms. Dortch:

The record in this proceeding supports expeditious grant of Amazon's application to launch and operate a non-geostationary satellite orbit fixed-satellite service ("NGSO FSS") system comprised of 3,236 satellites.[1] The Kuiper System will deliver high-throughput, low-latency satellite broadband services to tens of millions of unserved and underserved consumers and businesses in the United States and around the globe. The Commission's prompt grant of U.S. launch and operating authority, with the protections and conditions ordinarily applied to NGSO FSS applicants, will ensure that Amazon can promptly start providing customers innovative new broadband services.

Amazon has shown that the Kuiper System can share spectrum effectively. Amazon's conservative simulations demonstrate that the Kuiper System will not alter the reasonable expectations of participants in the current Ka-band processing round (the "Processing Round Participants") if Amazon is allowed to operate under the same spectrum-sharing framework the Commission established to encourage good-faith coordination among all NGSO operators. Amazon has shown that its system neither materially impacts the interference environment for

[1] *See* Application of Kuiper Systems LLC for Authority to Launch and Operate a Non-Geostationary Satellite Orbit System in Ka-band Frequencies, IBFS File No. SAT-LOA-20190704-00057 (filed July 4, 2019) ("Application"); Consolidated Opposition and Response of Kuiper Systems LLC, IBFS File No. SAT-LOA-20190704-00057 (filed Nov. 13, 2019) ("Opposition"). This written *ex parte* presentation responds to the various submissions made subsequent to the filing of the Opposition, which introduce new claims or information that Amazon did not previously have an opportunity to address. *See Satellite Policy Branch Information Actions Taken*, Public Notice, Report No. SAT-01404 (rel. July 26, 2019) (designating the Kuiper System proceeding as "permit-but-disclose" for purposes of the Commission's rules governing *ex parte* communications, effective July 25, 2019).

existing licensees, nor precludes future entry. Affording equitable access to spectrum and orbital resources will increase investment, innovation, and consumer choice.

During the comment period that concluded November 25, 2019, some commenters and Processing Round Participants urged the Commission to impose time-consuming and unnecessary regulatory obstacles to licensing on Amazon.[2] These demands rely on incorrect technical analysis, are unwarranted given the spectrum-sharing capabilities of the Kuiper System, and contradict the Commission's past decisions. Accepting these demands would harm the public interest, frustrate broadband deployment, and establish a precedent that would reduce satellite investment and innovation for years to come. Prompt grant of the Application, consistent with longstanding Commission precedent, would serve the public interest by bringing high-capacity, low-latency broadband to unserved and underserved consumers in the United States and worldwide.

I. AMAZON HAS DEMONSTRATED THE KUIPER SYSTEM'S ABILITY TO SHARE SPECTRUM EFFECTIVELY.

The Kuiper System's planned configuration can take full advantage of interference mitigation techniques such as small spot beams, satellite diversity, low orbital altitude, and frequency agility. Amazon remains committed to coordinating in good faith and to leveraging the extraordinary spectrum sharing capabilities of the Kuiper System.

A. Amazon's Conservative Simulations Demonstrate No Material Effect on Processing Round Participants' Reasonable Expectations.

Amazon has demonstrated that the Kuiper System will not undermine the Processing Round Participants' reasonable expectations if Amazon is allowed to operate under the same spectrum-sharing framework the Commission established to encourage good-faith coordination among NGSO operators.[3] Amazon's technical analysis shows that the Kuiper System will not materially impact the Ka-band operating environment when Processing Round Participants share spectrum as required by the Commission's rules.

Amazon's simulation model is conservative and includes assumptions that, if anything, overstate the percentage of time that interference could theoretically occur. Principal examples of how Amazon's approach is conservative and overstates the likelihood of interference include:

i. earth stations of the examined system and the Kuiper System are assumed to be always co-located, which maximizes the potential impact of interference events;[4]

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[2] *See, e.g.*, Reply of Space Exploration Holdings, LLC, IBFS File No. SAT-LOA-20190704-00057 (filed Nov. 25, 2019) ("SpaceX Reply"); Reply of WorldVu Satellites Ltd., IBFS File No. SAT-LOA-20190704-00057 (filed Nov. 25, 2019) ("OneWeb Reply"); Reply of SES Americom, Inc. and O3b Limited, IBFS File No. SAT-LOA-20190704-00057 (filed Nov. 25, 2019) ("SES/O3b Reply").

[3] *See* Opposition, Technical Appendix at D-1.

[4] *See id.* at T-5.

ii. earth stations of all other simulated systems are assumed to be also always co-located and could potentially block establishing a link with an alternative satellite;[5] and

iii. all satellites are assumed to use all available spectrum to communicate with their associated earth stations, which makes every in-line event an in-line *interference* event.[6]

Employing these highly conservative, counterfactual assumptions necessarily generates "false positives"—meaning geometric alignments that do not result in an increase in the interference noise temperature ($\Delta T/T$) of 6 percent or more. In reality, earth stations of multiple systems will neither generally be co-located, nor will those systems always use all available spectrum with every earth station.[7] Nonetheless, even using assumptions adverse to a showing of compatibility, Amazon's simulations demonstrate that good-faith coordination works to essentially eliminate harmful interference among NGSO FSS systems.[8] And as the Commission has said for two decades, and as SpaceX itself has acknowledged, the availability of satellite diversity makes coexistence without harmful interference especially feasible and practical.[9]

Because Amazon's conservative modeling shows a minimal and manageable risk of interference with good-faith coordination, the Processing Round Participants cannot plausibly claim that authorizing the Kuiper System would disrupt their reasonable expectations. The entry of the Kuiper System after the departure of LeoSat and Boeing has no material effect on the radiofrequency baseline, contrary to the claims of SpaceX and other parties.[10] Emphasis on the comparative number of satellites before and after the Kuiper System's entry without regard to system architecture and operational characteristics is not a scientifically or logically sound way

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[5] *See id.*

[6] *See id.*

[7] *Id.*

[8] *See id.* at T-1–T-2 (noting that information sharing will resolve most false positives and system-to-system coordination will resolve the remainder).

[9] *See Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ka-Band*, Report and Order, 18 FCC Rcd 14708, ¶ 44 (2003) ("*2003 Ka-Band NGSO FSS Order*") (explaining that satellite diversity allows "NGSO FSS systems [to] avoid an in-line interference event by selecting another visible satellite within their system constellation (performing a hand-over process) whenever the current satellite approaches the in-line event with a satellite operating in another NGSO FSS system constellation"); *Teledesic LLC for Minor Modification of License to Construct, Launch and Operate a Non-Geostationary Fixed Satellite Service System*, Order and Authorization, 14 FCC Rcd 2261, ¶ 17 (1999) ("*Teledesic*"); *see also* Comments of Space Exploration Technologies Corp., IB Docket No. 16-408, at 24-28 (filed Feb. 27, 2017) ("SpaceX NGSO FSS Comments") ("A system design that allows a customer to be served by more than one satellite at a time (a concept called 'satellite diversity') enables the operator to determine which specific satellite to use based on whether it would cause or receive interference from a satellite of another system. NGSO systems with these sorts of on-orbit flexibility present more options for potential spectrum sharing strategies than do less advanced systems whose operational capabilities are more constrained.").

[10] *See* SpaceX Reply at 8-9; Theia Holdings A, Inc., Reply to Consolidated Opposition, IBFS File No. SAT-LOA-20190704-00057, at 1-2 (filed Nov. 25, 2019) ("Theia Reply"); OneWeb Reply at 11-12.

to assess the likelihood and impact of interference. As SpaceX noted in 2017 when its own application was pending before the Commission, "the number of satellites deployed is far less important than the radiofrequency characteristics of a given NGSO constellation."[11]

In addition to substantial differences in network control and operational characteristics, several basic system configuration factors make the Kuiper System a much better steward of frequency and orbital resources than the systems of Boeing and LeoSat would have been. These factors include differences in satellite diversity and system flexibility as well as spot beam size and uplink power associated with orbital altitude.

Satellite Diversity and System Flexibility. The number of satellites in a constellation is driven by the system's service and coverage objectives, orbital altitude, and minimum elevation angle constraints. Higher altitude systems require fewer satellites because they are able to serve a particular location for longer durations; however, one drawback of having fewer satellites in view of any given point on Earth is that those systems will have less flexibility to select alternative satellites to avoid potential interference events. LeoSat, for example, would have routinely had access to only one or two alternative satellites at lower latitudes, as shown in the excerpt from LeoSat's technical appendix that is reproduced below.

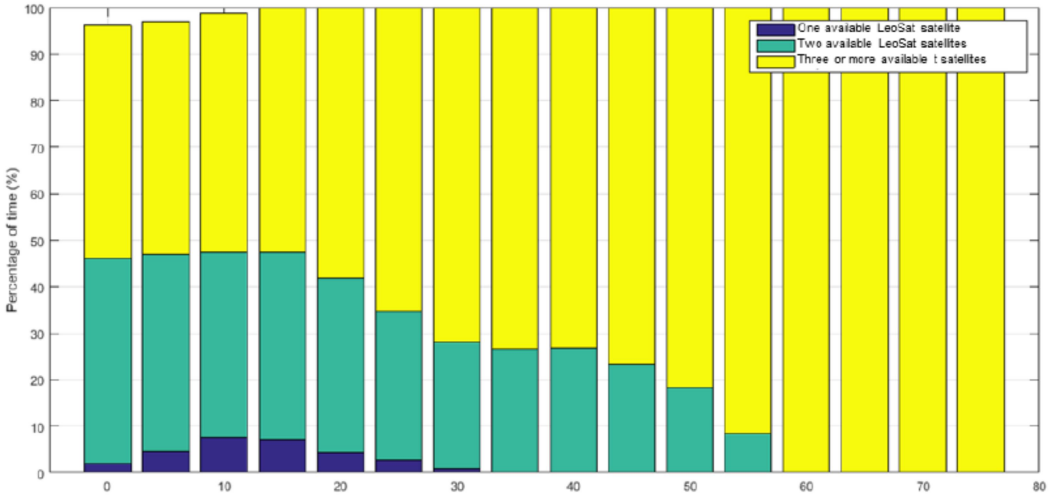

Figure 1: Excerpt of LeoSat's Technical Annex: "Number of available LeoSat satellites as a function of latitude"[12]

[11] SpaceX NGSO FSS Comments at 2.

[12] Technical Annex of LeoSat MA, Inc., IBFS File No. SAT-PDR-20161115-00112, at 29 (filed Nov. 15, 2016). This image from LeoSat's application shows the limited number of alternative satellite routing options LeoSat would have had, especially at lower latitudes where most of the world's population lives. Had LeoSat not surrendered its authorization, the limited number of satellite alternatives available to this NGSO FSS system would have limited coordination flexibility and imposed significant operational constraints on other NGSO FSS systems, such as SpaceX and OneWeb. LeoSat's departure from the radiofrequency environment provides both Processing Round Participants' systems and new entrants with considerable additional flexibility to operate.

The Kuiper System, by comparison, will have far more satellites alternatively available than LeoSat. Amazon's Technical Appendix shows an average of 15 Kuiper System satellites visible above a minimum elevation of 35° at 40° North latitude.[13] This large number of visible satellites allows Amazon to select alternate satellites to serve a desired ground location when a close angular conjunction occurs between Kuiper System satellites and other NGSO systems. The number of visible satellites far exceeds the number of satellites that use the same frequency at the same ground location. In other words, there are many possible ways to choose the "Nco" satellites from the visible satellites to avoid choices that might produce interference.[14] Other NGSO FSS systems with a significant number of satellites offering similar coverage have similar flexibility.

Orbital Altitude and Spot Beam Size. The altitude of a satellite has another direct effect on spectrum sharing given the geometric effects of distance and beamwidth: higher-altitude constellations generally have larger spot beams, which limit the spectrum-sharing benefits of earth station separation. As an example, Boeing's technical narrative proposed "spot beams" that covered entire states, and "regional beams," each of which covered a quarter of the continental United States.[15] Boeing's large spot beams would have been much more difficult to isolate from earth stations on the ground than smaller spot beams and would have substantially complicated interference avoidance and resolution. By comparison, the small and compact spot beams in the Kuiper System reduce the potential for in-line events and create new options for sharing among NGSO systems. For a sense of the difference in the size of the spot beams in their respective systems, Figure 2 below compares one of Boeing's smallest spot beams in yellow with one of the Kuiper System's spot beams in green.

[13] *See* Application, Technical Appendix at C-3.

[14] NGSO operators use the term "Nco" to refer to the maximum number of beams in any one frequency channel used to serve customers or gateways at any one geographical location. For customer terminals, Amazon has a maximum of one co-frequency beam per user; therefore, for Kuiper's user beam Nco equals one. For gateway terminals, Amazon's Kuiper System has a maximum of four co-frequency gateway beams; therefore, Kuiper's gateway Nco equals four.

[15] *See* The Boeing Company, Application, IBFS File No. SAT-LOA-20161115-00109, at 11, Fig. II-5 (filed Nov. 15, 2016) ("Boeing Application").

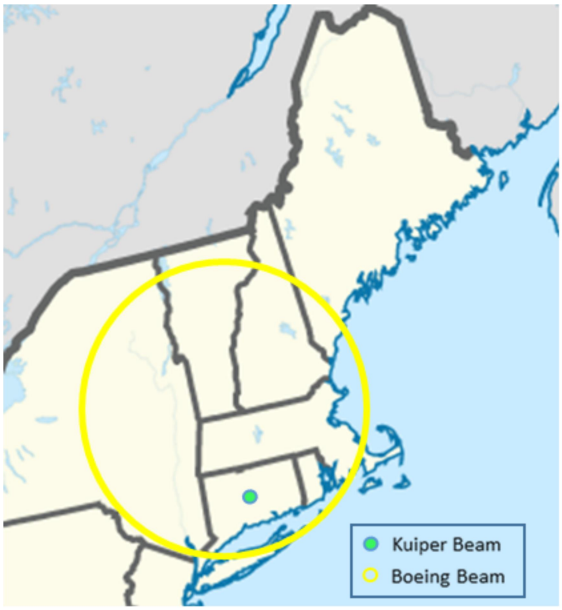

Figure 2: A Comparison of the Size of Boeing's Proposed Spot Beam (in yellow) with the Kuiper System's Spot Beam (in green)[16]

Orbital Altitude and Uplink Power. The Boeing system was a high-altitude constellation with gateway earth stations that would have required considerable uplink power to close links with wanted satellites high above Earth. Placing satellites in lower altitude orbits allows operators to reduce the equivalent isotropically radiated power ("EIRP"). The use of lower EIRP, in turn, benefits all other systems in the band by reducing noise in the Earth-to-space direction that could otherwise decrease system performance of other satellite operations. The Commission recently approved SpaceX's request to modify the altitude of 1,584 of the company's licensed spacecraft to 550 kilometers with this principle in mind.[17] According to the Commission, SpaceX's proposal to operate at a lower altitude "is expected to result in lower power needed to be transmitted from earth stations to SpaceX's satellites" because "shorter distances between the earth station and the satellite will result in smaller path losses."[18]

In contrast to LeoSat, which had a limited ability to use satellite diversity, and Boeing, which lacked small spot beams and low-power uplinks given its altitude, the Kuiper System will have all of these features to support coexistence with other systems. Indeed, Amazon has proposed a system configuration that can take full advantage of interference-mitigation techniques, such as small spot beams, satellite diversity, low orbital altitude, frequency agility, and more. The Kuiper System's high gain satellite antennas and low orbital altitude allows for small spot beams and reduces the interference radius around earth stations significantly, which permits Ka-band frequency reuse by multiple NGSO systems with small earth station separation

[16] *See id.* at 11. The Boeing beam footprints pictured here and in the Boeing Application represent only the main beam; the first side-lobe footprints extend much further.

[17] *Space Exploration Holdings, LLC Request for Modification of the Authorization for the SpaceX NGSO Satellite System*, Order and Authorization, 34 FCC Rcd 2526, ¶ 13 (2019).

[18] *Id.*

distances, even during what might otherwise be in-line events.[19] For these reasons, the Kuiper System not only has a far lower potential for interference, but also is far less susceptible to interference and far more flexible than the abandoned Boeing and LeoSat systems would have been.

As explained in its Opposition, Amazon has conducted simulations to quantify the benefits of the Kuiper System for the existing NGSO FSS operators.[20] This modeling explains, among other things, why an NGSO FSS constellation the size of the Kuiper System can have a smaller spectrum-sharing impact on Processing Round Participants than the now-defunct Boeing and LeoSat systems.

SpaceX suggests it reasonably expected to operate in a better radiofrequency environment than would have existed if all aspiring Processing Round Participants, including Boeing and LeoSat, had deployed their systems.[21] The notion is contrary to Commission policy and reason. If it is reasonable to expect operators to depart a radiofrequency environment,[22] it is equally reasonable to expect new operators to enter that same environment.[23]

B. SpaceX's Analysis of Gateway Earth Station Effects Rests on False Assumptions and Faulty, Internally Inconsistent Analysis at Odds with Commission Policy and Industry Practice.

SpaceX raises various technical objections related to its gateway earth station operations that are false, illogical, and internally inconsistent. This results-driven analysis should be afforded no weight.

SpaceX includes several incorrect assumptions that distort its analysis of multiple interference scenarios. First, SpaceX incorrectly conflates any geometry in which two potential links would, if both were active, exceed the 6 percent $\Delta T/T$ coordination trigger with lost connections.[24] In reality, the vast majority of in-line events are "false positives," and SpaceX

[19] *See* Application, Technical Appendix at 7-8.

[20] *See* Opposition, Technical Appendix at Attachment B; *see also id.* at E-1 ("[W]hen both [SpaceX and Kuiper] systems attempt to use available satellite diversity to resolve in-line events, the simulation results suggest there is a negligible impact on operation of the SpaceX system.").

[21] *See* SpaceX Reply at 5-6; *see also* OneWeb Reply at 11.

[22] *See* SpaceX Reply at 5-6.

[23] The Commission has allowed satellite operators into a band after the close of a processing round. For example, the Commission has previously waived the processing round rule and granted an operator access to spectrum after concluding that doing so "will neither preclude future systems from using the spectrum assigned" to the applicant "nor cause harmful interference to other operators in the band." *Space Imaging, LLC, Petition for Clarification of Amendment of the Commission's Space Station Licensing Rules and Policies,* Declaratory Order and Order and Authorization, 20 FCC Rcd 11964, ¶¶ 10-11 (2005) ("*Space Imaging*").

[24] *See* Comments of Space Exploration Holdings, LLC, IBFS File No. SAT-LOA-20190704-00057, at 8-10 (filed Oct. 28, 2019) ("SpaceX Comments"); SpaceX Reply at 10.

and Amazon would coordinate to avoid link losses in the context of potential interference events. NGSO operators can resolve false positives without mitigation by disclosing their frequency usage and other operational parameters through good-faith coordination.[25] SpaceX has previously acknowledged that "[s]haring of beam-pointing information among all NGSO system operators would significantly identify and reduce false in-line events."[26] Second, SpaceX exaggerates the percentage of links that theoretically require coordination because it arbitrarily models only 1,584 satellites in its constellation rather than all 4,409 satellites in its system.[27] Limiting satellite diversity by changing the denominator from 4,409 to 1,584 overestimates the percentage impact of the Kuiper System's gateway operations. Third, the trigger for coordination of 6 percent ΔT/T is not the interference threshold, which SpaceX itself has said could be closer to 25 percent ΔT/T.[28] Using a 6 percent ΔT/T as an indicia of interference inflates the incidence of interference events compared to 25 percent ΔT/T—a fact SpaceX correctly noted in its filings leading up to the *NGSO FSS Order*.[29] Fourth, all of SpaceX's objections to the Kuiper System's operations focus on potential interference into SpaceX's gateway earth stations, which are far less numerous and much easier to coordinate than ubiquitous customer terminals.[30] Good-faith coordination with basic attention to site and frequency selection should resolve any issues.

The theoretical interference scenarios SpaceX raises are discussed below, including (1) Kuiper System gateway downlinks into SpaceX gateways; (2) Kuiper System customer terminal downlinks into SpaceX gateways; and (3) Kuiper System customer terminal uplinks into SpaceX gateway uplinks.[31]

- **Kuiper System Gateway Downlinks and SpaceX Gateways.** SpaceX claims its geometric analysis shows that SpaceX will lose 35.8 percent of its connections if Kuiper System gateway downlinks are allowed to support delivery of broadband services to the public.[32] However, SpaceX incorrectly calculates the Kuiper System gateway beta angle,

[25] *See* Opposition, Technical Appendix at T-6.

[26] Letter from William M. Wiltshire, Counsel to SpaceX, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 16-408, Attachment, at 9 (filed Sept. 15, 2017) ("SpaceX NGSO FSS Ex Parte").

[27] In certain isolated instances, SpaceX appears to rely on the 4,409-satellite figure to calculate certain values. SpaceX has offered no explanation for when—much less why—it calculates values using 1,584 satellites as opposed to the 4,409 satellites that it intends to deploy.

[28] *See* SpaceX Reply at 8. For context, a 6 percent ΔT/T raises the noise floor by just 0.25 dB, whereas 25 percent ΔT/T raises the noise by 1 dB, which the Commission routinely uses to identify acceptable interference.

[29] *See* SpaceX NGSO FSS Ex Parte at 3.

[30] *See* SpaceX Comments at 8-14; SpaceX Reply at 10.

[31] Amazon notes, in the interest of comprehensiveness, that one other theoretical interference scenario exists: Kuiper System gateway uplinks into SpaceX gateways. This scenario poses no serious issue and no party—not even SpaceX—raised the subject. The interference risk is exceptionally low and, in any case, readily avoided.

[32] *See* SpaceX Comments at 8-10; SpaceX Reply at 7.

which means SpaceX exaggerates the effect of the Kuiper System's operation on SpaceX's gateways[33] and ignores the mitigating effect of geographic separation of gateway earth station locations. In its quantitative analysis, SpaceX claims that interference from Kuiper System gateway downlinks will exceed 6 percent ΔT/T 3.9 percent of the time for SpaceX gateway earth stations.[34] Yet SpaceX has failed to demonstrate how 35.8 percent of SpaceX's gateway links are lost due to the operation of Kuiper System gateway downlinks in a geometric analysis if the parties only exceed the 6 percent Δ T/T coordination threshold 3.9 percent of the time when the SpaceX gateways and Kuiper System gateways are pointed randomly. Even the analysis yielding 3.9 percent, although more realistic because it assumes each system selects only Nco links rather than avoid all false-positive in-line geometries, still assumes no communication between operators, which (as detailed in the following discussion regarding Figure 3) makes any instance of exceeding the 6 percent ΔT/T threshold negligible.

- **Kuiper System Customer Terminal Downlinks and SpaceX Gateways.** SpaceX claims its geometric analysis shows that SpaceX will lose 69 percent of its connection due to interference from Kuiper System customer terminal downlinks.[35] Again, SpaceX ignores the benefits of good faith coordination, conflates triggering an obligation to pursue coordination with losing a link,[36] and exaggerates the likelihood of coordination by inexplicably dropping the denominator in its calculations from 4,409 to 1,584. Moreover, when coordination is needed, both Amazon and SpaceX would have many tools at their disposal not only to avoid lost connections, but also to ensure continuous, robust operations.[37] In its quantitative analysis, SpaceX claims the Kuiper System's customer terminal downlinks will exceed 6 percent ΔT/T 5.3 percent of the time for SpaceX gateway earth stations.[38] The purported 5.3 percent of customer terminals downlinks exceeding 6 percent ΔT/T shows the flaw in SpaceX's geometric downlink analysis. SpaceX has failed to demonstrate how 69 percent of SpaceX's gateway links could possibly be lost due to Kuiper System customer terminal downlinks when, by SpaceX's own calculations, the Kuiper System's operations only exceed the 6 percent

[33] Six percent ΔT/T corresponds to -12.2 dB I/N, where I/N can be calculated as:

$$\frac{I}{N} = PFD + 10log_{10}\left(\frac{\lambda^2}{4\pi}\right) + \frac{G}{T} - G_{peak} + G(\theta) - boltz,\ G(\theta) = 32 - 25log_{10}(\theta)$$

Using the numbers in SpaceX's table, I/N in their victim GW is ~-18 dB at 11 deg beta

$$-123\ dB\left(\frac{W}{m^2 MHz}\right) - 46.5\ dB(m^2) + 22.5\ {}^{dBi}/_{K} - 45.5\ dBi + 6\ dBi + 168.6\ dB\left(\frac{MHzK}{W}\right) = -18\ dB$$

and requires 6 dB higher PFD to recover -12.2 dB I/N. This error exaggerates the area of the sky that is affected by a factor of three.

[34] *See* SpaceX Comments at 8-10; SpaceX Reply at 7.

[35] *See* SpaceX Comments at 10-11; SpaceX Reply at 7.

[36] *See* 47 C.F.R. § 25.261(b).

[37] Opposition at 16-18.

[38] SpaceX Comments at 12.

ΔT/T coordination threshold 5.3 percent of the time when the SpaceX gateways and Kuiper System customer terminals are pointed randomly.[39]

- **Kuiper System Customer Terminal Uplinks and SpaceX Gateway Uplinks.** SpaceX claims the Kuiper System's customer terminal uplinks will interfere with SpaceX gateway uplinks.[40] However, interference from Kuiper System customer terminal uplinks into SpaceX gateway uplinks could only occur following a remarkable confluence of geometric alignments, inattentive frequency selections, and poor site selections, which are entirely preventable in practice. This implausible interference scenario can exist only if—contrary to SpaceX's own public advocacy[41] and Amazon's clear commitments—*neither SpaceX nor Amazon* would share *any* information about their operations and neither party would coordinate their operations in any fashion. Such an assumption is not realistic. The SpaceX results are also skewed by the omission of 2,825 satellites in its system located at 1,100 kilometers or higher, which receive less interference than those located at an altitude of 550 kilometers because the communications paths are much longer for the more distant satellites. Commercially reasonable information sharing and the good faith coordination that the Commission's rules already require will more than address SpaceX's purported concerns.

In addition, SpaceX produced data designed to illustrate how the Kuiper System would ostensibly reduce the average number of SpaceX "connections" by 24 percent.[42] Reproducing the data plot SpaceX submitted, however, requires the same incorrect assumptions described above. Namely, reproducing the plot requires assuming that every SpaceX link that geometrically falls within the overlapping beta angles of SpaceX and another constellation link is "lost." This assumption is tantamount to taking fallacies as fact, including: (i) SpaceX would act as if it were inferior to every other operator rather than coordinate in good faith pursuant to Section 25.261; and (ii) every other operator either disregards its Nco limit and uses all visible satellites, or shares no information about which links it intends to use.

Amazon has replicated SpaceX's analysis of the probability that certain minimum numbers of satellites will be available at 40º North latitude. The dashed red line in the graphic below shows the maximum number of co-frequency satellite gateway links SpaceX can support

[39] For the same reasons identified in the discussion of purported issues between Kuiper System gateway downlinks and SpaceX gateways, the purported 5.3 percent rate of exceeding the 6 percent ΔT/T trigger is itself greatly exaggerated.

[40] *See* SpaceX Reply at 7.

[41] SpaceX NGSO FSS Comments at 18-19 ("NGSO operators must know the location of co-frequency NGSO space stations in other constellations in order to effectuate the avoidance of in-line events sharing mechanism."); Comments of Space Exploration Holdings, LLC, IBFS Nos. SAT-LOA-2016-1115-00117, et al., at 1 (filed July 17, 2017) ("[T]he Commission should seek additional information about the sharing capabilities of the NGSO systems . . . to ensure that valuable spectrum is not wasted through . . . poor information sharing."); *id.* at 11 (demonstrating potential in-line events with and without information sharing).

[42] *See* SpaceX Reply at 8.

to a single gateway earth station, which is four.[43] Curve 2 in Figure 3, below, shows what SpaceX claims to be the available links with all the Processing Round Participants, and Curve 1 shows SpaceX's claim of the links available after Boeing and LeoSat are removed, but the Kuiper System is added. The purported reduction in average number of satellites in view shown by Curve 1 relative to Curve 2 is only possible if SpaceX does not intend to engage in even the most rudimentary form of information sharing, which would avoid the false positives assumed in SpaceX's approach.

Cumulative Distribution Function ("CDF") of Satellites at 40⁰ North Latitude

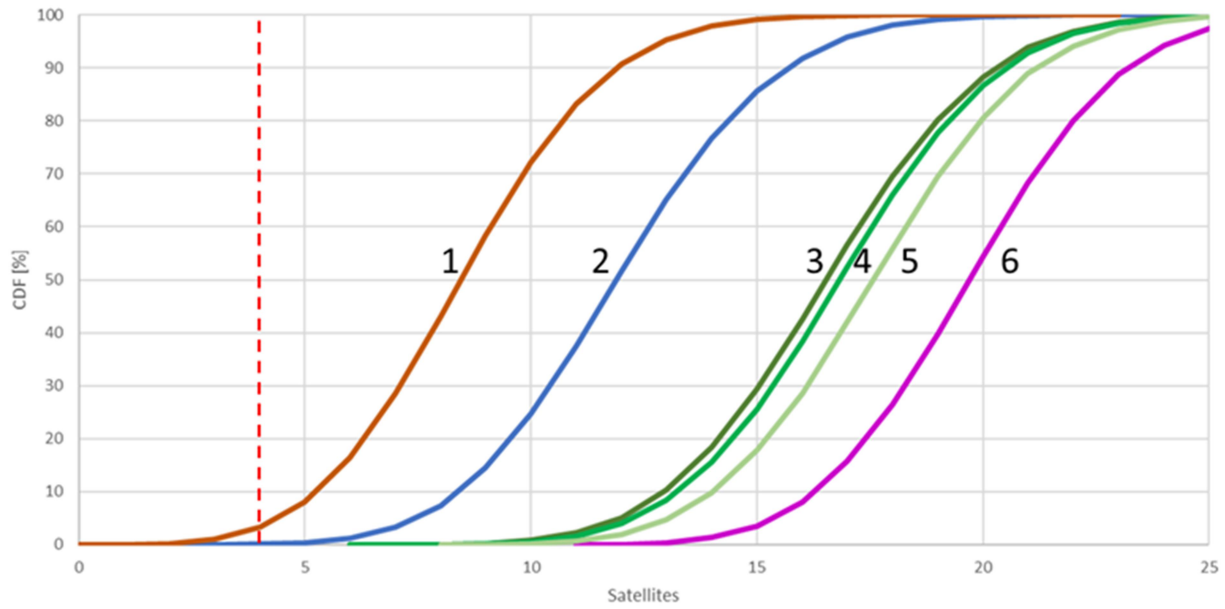

Figure 3: Once Corrected for Errors and Omissions, SpaceX's CDF Analysis at 40⁰ North Latitude Demonstrates that the Kuiper System Has No Material Impact on SpaceX Satellites

A more accurate assessment would consider the significant improvement in available satellites if SpaceX were to use the satellite diversity inherent in its system design to avoid potential interference events. Curve 3 illustrates the unrealistic scenario in which every other Processing Round Participant randomly selects Nco links from available satellites, and SpaceX selects links from its remaining available satellites with no further coordination than knowing which links the other operators chose.[44] In other words, Curve 3 shows a scenario in which SpaceX uses satellite diversity to resolve actual in-line events, but does not share its own active link information nor engage in any additional coordination with other systems. The resulting increase in available satellites confirms that merely receiving active link information from other operators resolves many in-line events and, in SpaceX's case, significantly increases the number of available satellites, even without considering improvements if other systems exercise their

[43] *See generally, e.g.*, *SpaceX Order and Authorization* ¶16.

[44] In other words, SpaceX is aware of, and avoids, the active links of other operators in the scenario depicted by Curve 3.

satellite diversity in good faith coordination to further resolve potential in-line events with SpaceX.

Curve 4 removes Boeing and LeoSat and adds the Kuiper System, with SpaceX still avoiding all other systems. Curve 4 illustrates that the Kuiper System provides better opportunities for coexistence than Boeing and LeoSat combined given the specific operational characteristics of the Kuiper System, such as more satellites, small spot beams, and related features. The approximate doubling of available satellites from Curve 1 to 4 (which consider the same cases as Curves 2 and 3, but with Boeing and LeoSat removed and Kuiper added), illustrates that in this situation the availability of satellites to SpaceX even improves. Curve 5 reflects the same operators as Curve 4 but illustrates further improvement when the Kuiper System selects links from satellites without in-line geometry to SpaceX links, where available.

As a user of the spectrum engaging in bilateral coordination, SpaceX can expect to do better than Curve 5, because not all operators will co-locate all of their earth stations with those of SpaceX. Indeed, when good faith coordination under Section 25.261 is considered, SpaceX can approach or reach the best possible case result depicted in Curve 6—namely, gaining access to all available satellites at all times. SpaceX can arrive at this result by information sharing among all operators to identify false positives and by mutually implementing reasonable accommodations to resolve potential interference events.

The critical error in SpaceX's analysis is conflating lost links with any link that has the geometric potential for increasing their noise floor by 6 percent $\Delta T/T$, regardless of whether the links are used. This false assumption misrepresents real-world conditions and vastly overstates the impact to SpaceX of the operation of other systems, such as the Kuiper System. SpaceX uses the same faulty reasoning to argue that constellations with more satellites reduce the link availability more than constellations with fewer satellites when, for the same Nco, constellations with more satellites actually create more options for operating compatibly. Assuming both systems operate as required by Section 25.261, as they must, the Kuiper System has essentially no effect on SpaceX's link availability.

In short, SpaceX's claims of gateway earth station link "losses" are based on analysis that is rife with errors and inaccurate assumptions.

C. SpaceX's Criticisms of Amazon's Simulations Inflate the Likelihood of Interference Where None Would Exist.

Opponents have presented no credible facts to support allegations that the Kuiper System would lead to more interference relative to the baseline radiofrequency environment established in 2016 when the Processing Round Participants filed their applications. SpaceX, the sole commenter that attempted to provide technical analysis, relied on faulty assumptions that result in an overstated portrayal of increased interference.[45]

[45] *See generally* SpaceX Reply.

SpaceX substantially overstates the likelihood of interference by mischaracterizing in-line events as unresolvable scenarios that render links "lost" or incapable of service.[46] SpaceX also selectively highlights Amazon's data to hypothesize that grant of the Application would lead to an increase in interference events involving SpaceX's system by 3.8 percent to 6.3 percent.[47] The entries SpaceX cites, however, represent values calculated under the assumption that no information sharing or coordination would occur. But data three columns to the right in the very same table SpaceX cites, which is shown in Figure 4 below, demonstrates a reduction in potential interference events under assumptions of good-faith coordination. The Kuiper System greatly improves SpaceX's prospects when taking into account information sharing and satellite diversity.[48]

		No System in the Simulation Resolves In-Line Events			Kuiper and Examined System Resolve In-Line Events		
Earth Station Latitude (Degrees)	SpaceX Only (% Time at or above Nco)	Sharing with Authorized & Previously Filed Systems	Add Kuiper, Remove Boeing & LeoSat	Difference (% of Time at or Above Nco)	Sharing with Authorized & Previously Filed Systems	Add Kuiper, Remove Boeing & LeoSat	Difference (% of Time at or Above Nco)
0	98.9	75.1	68.9	-6.3	97.29	97.84	***0.54***
10	99.3	75.7	69.9	-5.8	98.22	98.52	***0.30***
20	100.0	71.2	67.2	-4.0	99.76	99.85	***0.09***
30	100.0	72.4	68.3	-4.1	100.00	100.00	***0.00***
40	100.0	76.8	73.1	-3.8	100.00	100.00	***0.00***
50	100.0	78.2	72.9	-5.3	100.00	100.00	***0.00***
60	100.0	68.2	75.0	***6.7***	100.00	100.00	***0.00***

Figure 4: SpaceX 6% ΔT/T - Multi-System Downlink Simulation Results (Percentage of Time Nco Satisfied: No Use of Satellite Diversity vs. Mutual Use of Satellite Diversity)[49]

By ignoring this information in its Reply, SpaceX mischaracterizes in-line events as link losses when, in fact, they can be resolved through the good-faith coordination that Section 25.261 requires.

The imprecise way SpaceX treats satellite diversity further illustrates the flaws in its analysis. For example, SpaceX claims that Amazon has developed a baseline scenario that assumes all operators deploy but no systems use satellite diversity to avoid interference.[50] In reality, Amazon has used a baseline that assumes that all Processing Round Participants deploy, and then illustrates how the systems would perform in two scenarios. In the first scenario, Amazon measures how often Processing Round Participants would expect to default to spectrum

[46] *See, e.g.*, *id.* at 8 ("For each scenario, we compute the number of SpaceX satellites that are visible and not subject to an in-line event and plot the results in Figure 1 below. From this, we calculate that on average SpaceX will lose just over 24% of connections compared to the baseline scenario when Amazon's NGSO system is introduced.").

[47] *Id.* at 10 (citing Opposition, Technical Appendix at B-7, Table 9).

[48] Opposition, Technical Appendix at B-7, gaiTable 9.

[49] *Id.*

[50] *See* SpaceX Reply at 4.

splitting without coordination and information sharing.[51] In the second, Amazon runs the same analysis under the condition that coordination and information sharing take place.[52]

By contrast, SpaceX's simulations assume that Processing Round Participants would *not* engage in good faith coordination.[53] This assumption is contrary to the Commission's rules[54] and Amazon's repeated commitment to coordinate in good faith.[55] SpaceX's analysis, however, not only discounts the role good faith coordination can play in resolving potential conflicts, but also rejects the possibility that Processing Round Participants would employ satellite diversity to resolve in-line events.[56] Of course, as SpaceX has advocated[57] and the Commission has long recognized,[58] satellite diversity is a critical piece of the interference-avoidance puzzle for NGSO FSS operators.

Amazon's simulations confirm SpaceX's original advocacy. Amazon's simulations demonstrate that when SpaceX's system and the Kuiper System both employ satellite diversity to resolve in-line events, virtually all of the projected in-line events that would have occurred absent satellite diversity vanish.[59] By ignoring good-faith coordination and satellite diversity in

[51] Opposition, Technical Appendix at B-7, Table 9.

[52] *See id.*

[53] *See* SpaceX Comments at 12 (conceding that it may be possible to mitigate the extreme effects SpaceX has forecasted through good-faith coordination).

[54] While SpaceX skews its analysis by assuming no coordination with the Kuiper System, the Commission correctly expects that NGSOs will coordinate in good faith. *See* 47 C.F.R. § 25.261(b) ("NGSO FSS operators must coordinate in good faith the use of commonly authorized frequencies.").

[55] *See, e.g.*, Opposition at 16.

[56] *See* SpaceX Comments at 8-12 (presenting statistics that do not account for the mitigating effect of good-faith coordination).

[57] SpaceX has acknowledged that Processing Round Participants can, in fact, use satellite diversity successfully to resolve in-line events. "[A]n NGSO system with more satellites with overlapping coverage," SpaceX wrote in 2018, "tends to have a greater ability to use satellite diversity to facilitate coordination during in-line interference events." Reply of Space Exploration Holdings, LLC, IBFS File No. SAT-MOD-20180319-00022, at 5 (filed Sept. 12, 2018); *see also* SpaceX Reply at 4 (conceding that multiple NGSO systems will use satellite diversity to make the interference environment less noisy than the baseline scenario). Elsewhere, SpaceX has acknowledged that "smaller systems actually make sharing more difficult in many respects. Larger systems, with greater satellite diversity, have more options for serving a given customer from multiple satellites—an obvious strategy for avoiding in-line events." Reply Comments of Space Exploration Technologies Corp., IB Docket No. 16-408, at 6 (filed Apr. 10, 2017). Accordingly, SpaceX has urged that "[t]he Commission's rules should reward those systems that facilitate such sharing, as they benefit all NGSO FSS operators and enable them to make more efficient use of valuable spectrum resources." SpaceX NGSO FSS Comments at 28.

[58] *See, e.g.*, *2003 Ka-Band NGSO FSS Order* ¶ 44 (explaining that satellite diversity allows "NGSO FSS systems [to] avoid an in-line interference event by selecting another visible satellite within their system constellation…."); *Teledesic* ¶ 17.

[59] *See* Opposition, Technical Appendix at Attachment B; *see also id.* at E-1 ("[W]hen both [SpaceX and Kuiper] systems attempt to use available satellite diversity to resolve in-line events, the simulation results suggest there is a negligible impact on operation of the SpaceX system.").

its latest modeling, SpaceX inaccurately projects that the Kuiper System would materially impair the interference environment when, in fact, no such impairment would occur.[60]

The Commission's rules also do not require Amazon to apply its interference model to a hypothetical future applicant, as some opponents suggest.[61] And for good reason: it is not feasible to speculate on future NGSO entry in the abstract. No two NGSO systems have the same number or type of satellites, orbital planes, altitudes, frequencies, earth stations, or repointing flexibility, among other characteristics. Modeling future entry, as some commenters suggest should be done, would require speculative assumptions about the design and operation of systems that will never be built and have not been proposed or even conceived.[62] Like Amazon, future applicants may show how their systems will not materially affect the NGSO FSS operational environment. Amazon is prepared to coexist with any future applicant who demonstrates a capacity to work collaboratively to ensure that all authorized NGSO FSS systems can effectively serve their customers. The current Processing Round Participants should do no less.

II. AMAZON HAS PROVIDED ALL NECESSARY INFORMATION FOR THE COMMISSION TO PROCESS THE KUIPER SYSTEM APPLICATION PROMPTLY.

A. EPFD and PFD Showings

Concerns about the sufficiency of Amazon's technical showings are misplaced. Contrary to the position of some commenters,[63] for example, the Commission need not delay processing of the Application based on Amazon's EPFD and PFD showings. In March 2019, Amazon submitted its Coordination Request filings, as required by Article 9 of the ITU's Radio Regulations and Section 25.111 of the Commission's rules.[64] These filings meet the same

[60] If SpaceX's apparent suggestion that only a handful of applicants from the previous processing round will proceed to full deployment proves correct, *see* SpaceX Reply at 5-6, then coordination will actually be even easier and should greatly reduce the effect of the Kuiper System's deployment on the interference environment.

[61] *See id.* at 11; SES/O3b Reply at 13-14 (asserting that Amazon failed to consider future applicants or the pending modification applications of OneWeb and SpaceX to expand their constellations).

[62] *See* SpaceX Reply at 11; SES/O3b Reply at 13-14.

[63] *See, e.g.*, SpaceX Reply at 22; OneWeb Reply at 13-14; SES/O3b Reply at 16-17.

[64] *See* ITU-RR, 9.6-9.44; 47 C.F.R. § 25.111; *see also* Letter from Jose Albuquerque, Director, Chief, Satellite Division, International Bureau, FCC to Director, Radiocommunication Bureau, ITU, I-2019-009247, (Mar. 26, 2019), https://bit.ly/30icmbp (submitting coordination request information for a new NGSO/FSS satellite system, USASAT-NGSO-8A); Letter from Jose Albuquerque, Director, Chief, Satellite Division, International Bureau, FCC to Director, Radiocommunication Bureau, ITU, I-2019-009250 (Mar. 26, 2019), https://bit.ly/2NlH0ve (submitting coordination request information for a new NGSO/FSS satellite system, USASAT-NGSO-8B); Letter from Jose Albuquerque, Director, Chief, Satellite Division, International Bureau, FCC to Director, Radiocommunication Bureau, ITU, I-2019-009249 (Mar. 26, 2019), https://bit.ly/2Nky21h (submitting coordination request information for a new NGSO/FSS satellite system, USASAT-NGSO-8C).

regulatory requirements the Processing Round Participants met in their filings.

Article 22 of the ITU Radio Regulations identifies certain EPFD limits that operators must satisfy.[65] Amazon satisfies the applicable ITU EPFD limits and corresponding Commission rules through avoidance of the geostationary arc, careful frequency selection, and limits on spectrum reuse, among other approaches.[66] These measures represent proven techniques to avoid potential interference. Amazon has submitted the required data and its EPFD calculations to the ITU, which will publish the information. The EPFD showings are, like those of all operators, subject to update once the ITU begins its examination process.[67] Kuiper has committed to comply with the applicable EPFD limits in Article 22 of the ITU Radio Regulations and has received a "qualified favorable" finding in accordance with Resolution 85 (WRC-03).[68] No other condition or stipulation is required to ensure compliance with Article 22 and corresponding domestic rules.

Article 21 of the ITU Radio Regulations, meanwhile, requires NGSO FSS operators to satisfy power flux-density ("PFD") limits to protect terrestrial operations from interference.[69] Amazon has calculated the maximum downlink PFD levels produced by each Kuiper System satellite from each of the three constellation shells at 630 kilometers, 610 kilometers, and 590 kilometers to demonstrate compliance with the limits.[70] Amazon is willing to be bound by the standard condition of grant regarding PFD limits.[71]

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[65] ITU-RR, Article 22 (requiring NGSO FSS operators demonstrate that EPFD shall not exceed certain specified limits for certain percentages of time based on frequency of operation and other factors); *see also* 47 CFR § 25.146(c). Consistent with the obligations required of similarly situated authorization holders, Amazon also intends to cooperate with other NGSO FSS operators to ensure that all authorized operations jointly comport with the applicable limits for aggregate equivalent PFD in the space-to-Earth direction (EPFDdown) contained in Article 22 of the ITU Radio Regulations, as well as Resolution 76 (WRC-15) of the ITU Radio Regulations.

[66] *See* Opposition at 25-27.

[67] *See, e.g.*, Letter from François Rancy, Director, ITU-BR, to Administrations of ITU Member States, Circular Letter CR/414 (Dec. 6, 2016); *Space Exploration Holdings, LLC Application for Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System, Application For Approval For Orbital Deployment And Operating Authority for the SpaceX NGSO Satellite System Supplement*, Memorandum Opinion, Order and Authorization, 33 FCC Rcd 3391, ¶ 40(n) (2018) ("*SpaceX Authorization Order*"); *WorldVu Satellites Limited Petition for a Declaratory Ruling Granting Access to the U.S. Market for the OneWeb NGSO FSS System*, Order and Declaratory Ruling, 32 FCC Rcd 5366, ¶ 24(d) (2017) ("*OneWeb Authorization Order*").

[68] *See* ITU-BR, CR/C/5024, CR/C/5025, CR/5026 (Sept. 17, 2019) (issuing Amazon "qualified favourable" and "favourable" ratings for its proposed system).

[69] ITU-RR, Article 21 (requiring the observation of certain PFD limits to protect terrestrial systems from downlink interference); *see also* 47 CFR §§ 25.208, 25.146(a)(1).

[70] *See* Application, Technical Appendix, Annex A at A-2.

[71] Consistent with the obligations required of similarly situated authorization holders, Amazon will ensure that any Kuiper System downlink operations produce a PFD level no greater than that allowed in any operating band subject to Article 21 of the ITU Radio Regulations.

B. Space Safety Showings

Amazon remains committed to space safety as demonstrated in its Application and elsewhere,[72] and it will satisfy international and national space safety standards to limit orbital debris and otherwise operate the Kuiper System consistent with applicable requirements. Amazon will submit a comprehensive Debris Assessment Software ("DAS") analysis to supplement the Application when it has finalized the Kuiper System's satellite materials and components. The Commission may condition grant of the Application on submission and approval of the detailed orbital debris analysis tailored to the system once the critical design review is complete and all system components and configurations are finalized.[73]

Amazon has provided sufficient information to the Commission regarding the Kuiper System's safe management of crossing points among its shells,[74] notwithstanding OneWeb's contention to the contrary.[75] The Kuiper System's orbital shells will have an inter-shell altitude separation of 20 kilometers and intra-shell, in-track satellite separation of at least 50 kilometers.[76] This inter-shell altitude spacing, and intra-shell, in-track satellite separation distances, essentially eliminate the potential for collisions among Kuiper System satellites. Here too, the Commission may condition any authority on submission and approval of the detailed collision avoidance and maneuverability analysis once all system components and configurations are final.[77]

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[72] *See* Letter from C. Andrew Keisner, Lead Counsel, Kuiper Systems LLC, to Jose Albuquerque, Chief, Satellite Division, International Bureau, FCC, IBFS File No. SAT-LOA-20190704-00057, at 1 (Sept. 18, 2019) ("Orbital Debris Letter"); Application, Technical Appendix at 30.

[73] For example, in its recent grant of SpaceX's modification request, the Commission conditioned such authorization on satisfactory showing of SpaceX's orbital debris mitigation plans. *See Request for Modification of the Authorization for the SpaceX NGSO Satellite System*, Order and Authorization, IBFS File No. SAT-MOD-20190830-00087, ¶ 19(q) (rel. Dec. 19, 2019) ("Upon finalization of its space station design and prior to initiation of service, SpaceX must seek and obtain the Commission's approval of a modification containing an updated description of the orbital debris mitigation plans for its system for any satellites other than those that will be operated at an altitude of 550 kilometers as proposed in this modification."). The Commission imposed similar conditions on SpaceX's original application approval. *See SpaceX Authorization Order*, ¶ 15 ("Pending further study, it would be premature to grant SpaceX's application based on its current orbital debris mitigation plan. Accordingly, we believe it is appropriate to condition grant of SpaceX's application on the Commission's approval of an updated description of the orbital debris mitigation plans for its system.").

[74] *See* Opposition at 32-34; Orbital Debris Letter at 1-2.

[75] OneWeb Reply at 13.

[76] *See* Opposition at 33; Orbital Debris Letter at 1.

[77] *See, e.g.*, *SpaceX Authorization Order* ¶ 40(p) ("Upon finalization of its space station design and prior to initiation of service, SpaceX must seek and obtain the Commission's approval of a modification containing an updated description of the orbital debris mitigation plans for its system…").

C. Other Technical Showings

Some commenters wrongly insist that additional technical showings are required. Citing no Commission requirements, OneWeb criticizes Amazon for failing to "analyze the interference impacts of the Kuiper System alone."[78] SES/O3b argue that Amazon should show how it will share spectrum with future entrants, including potential expanded constellations of OneWeb and SpaceX.[79] Theia criticizes Amazon for conducting its technical analysis on a system-to-system basis rather than assessing effects on an environment-wide basis,[80] whereas SpaceX criticizes Amazon for the opposite—that is, its "approach of modeling a multi-system sharing environment instead of assessing the impact its system would have on each individual first-round NGSO system."[81]

The Commission's rules do not require applicants to use specific simulation modeling or otherwise limit the scope of permissible spectrum sharing demonstrations. Rather, applicants can provide a wide range of information in support of the Commission's general public interest assessment and the case-by-case analysis adopted in paragraph 61 of the *NGSO FSS Order*.[82] Amazon should neither be faulted for failing to conduct any of the commenters' disparate and conflicting preferred analyses, nor required to satisfy commenters' contradictory and nebulous requests as a condition of licensing. Instead, the Commission should evaluate on its own merits the extensive spectrum sharing and related demonstrations provided by Amazon in this proceeding.

Moreover, Amazon's technical demonstrations are more conservative and compelling than system-to-system or other analyses suggested by commenters. Amazon's extensive multi-system simulations incorporate the potential operational impact of the Kuiper System and other authorized NGSO FSS systems. Such an approach is essential to evaluate the effects of the Kuiper System on the overall operational environment and obviates the need for system-to-system analyses because the results of those analyses necessarily would be better given that only the Kuiper System (rather than all authorized systems) would be included. Amazon has demonstrated conclusively that it can share spectrum with remaining Processing Round Participants and new entrants, and Amazon intends to coordinate in good faith on an operator-to-operator basis as required by Section 25.261 to maximize the efficient use of spectrum and orbital resources.

Elsewhere, some opponents suggest simultaneously that: (i) Amazon failed to show that it could operate without a waiver; and (ii) Amazon failed to show that it *could not* operate

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[78] *See* OneWeb Reply at 10 (emphasis omitted).

[79] *See* SES/O3b Reply at 13-14.

[80] *See* Theia Reply at 5.

[81] SpaceX Reply at 3.

[82] *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Report and Order and Further Notice of Proposed Rulemaking, 32 FCC Rcd 7809, ¶ 61 (2017) ("*NGSO FSS Order*").

without a waiver.[83] Here again, the Commission's rules or the standard for waiver do not require Amazon to satisfy these conflicting requests for additional showings. Amazon has made all of the showings required under the Commission's rules, and more.

III. EXPEDITIOUS GRANT OF THE APPLICATION SERVES THE PUBLIC INTEREST AND IS CONSISTENT WITH THE COMMISSION'S RULES.

A. Section 25.261 and the NGSO FSS Order Do Not Compel Inferior Status for the Kuiper System.

Section 25.261 is as broad as it clear: NGSO FSS operators must coordinate in good faith.[84] The provision applies to all NGSO FSS systems that operate with "earth stations with directional antennas anywhere in the world under a Commission license, or in the United States under a grant of U.S. market access."[85] If good-faith coordination fails, the rule requires NGSO FSS operators to split spectrum among systems involved in an in-line event if $\Delta T/T$ rises above 6 percent in either system.[86] The rule has no relevant exceptions or limitations: *all* qualifying NGSO FSS operators must coordinate in good faith or, if good-faith coordination fails, split the spectrum above a defined interference threshold. The rule also makes no distinction between small systems and large systems, between low earth orbit systems and medium earth orbit systems, or between first-moving systems and later-filing systems. At a minimum, nothing in Section 25.261 implies—much less commands—imposing an inferior status on later-filed systems like the commenters would want to apply to the Kuiper System.[87]

Consistent with the letter and spirit of Section 25.261's broad requirement to coordinate in good faith, the 2017 *NGSO FSS Order* provided that the "treatment of later applicants to approved systems must necessarily be case-by-case based on the situation at the time, and considering both the need to protect existing expectations and investments and provide for additional entry as well as any comments filed by incumbent operators and reasoning presented by the new applicant."[88] The Commission's 2017 *NGSO FSS Order* put all Processing Round Participants on notice that their systems may need to share with future NGSO FSS systems in the same spectrum bands.[89] The Commission also conditioned each Processing Round Participant's grant on compliance with future agency decisions. These authorizations contain conditions

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[83] *Compare* Petition to Dismiss or Defer of SES Americom, Inc. and O3b Limited, IBFS File No. SAT-LOA-20190704-00057, at 12 (filed Oct. 28, 2019) (asserting that applicants for waiver should demonstrate how operations could occur if the Commission were to deny a waiver request) ("SES/O3B Petition") *with* SpaceX Comments at 16 (asserting that applicants for waiver should explain how operations could not occur if the Commission were to deny a waiver request).

[84] 47 C.F.R. § 25.261(b).

[85] *Id.* § 25.261(a).

[86] *Id.* § 25.261(c).

[87] *See* SpaceX Reply at 17-18; OneWeb Reply at 8; SES/O3b Reply at 11-12.

[88] *NGSO FSS Order* ¶ 61.

[89] *See id.*

which state that "investments made toward operations . . . assume the risk that operations may be subject to additional conditions or requirements as a result of any future Commission actions."[90]

The Commission's case-by-case analysis balances "existing expectations and investments" and "provid[ing] for additional entry" in affording a new NGSO FSS applicant equal spectrum-sharing rights under Section 25.261.[91] Any given satellite system will, of course, vary in its ability to share. Where a proposed system's operation would materially impair existing expectations and investments of other NGSO FSS operators, the Bureau can condition that system's operation to make sharing more effective and equitable.[92] However, Section 25.261 does not change: good-faith coordination requirements and, in the absence of coordination, the specified spectrum splitting approach, apply to *all* qualifying NGSO FSS systems regardless of when their applications are received.[93]

In this case, Amazon's analysis has shown that the proposed Kuiper System can share spectrum effectively pursuant to Section 25.261 without a material effect on Processing Round Participants' reasonable expectations and existing investments. Because good-faith coordination is a requirement imposed on all NGSO FSS licensees under Section 25.261, the Processing Round Participants' spectrum sharing expectations and investments would not be materially impacted because potential in-line interference events can be resolved through inter-system coordination.[94]

Good-faith coordination advances the shared public interest in investment, innovation, and consumer choice. The FCC's spectrum access framework for NGSO systems has evolved from: (i) complicated frequency assignment plans that applicants developed on their own and which often took many years to finalize; to (ii) the current NGSO FSS framework designed to foster good-faith coordination and accommodate new entrants by taking advantage of directional

[90] *See, e.g.*, *SpaceX Authorization Order* ¶ 40(r); *OneWeb Authorization Order* ¶ 26 ("This grant of U.S. market access and any earth station licenses granted in the future are subject to modification to bring them into conformance with any rules or policies adopted by the Commission in the future.").

[91] *NGSO FSS Order* ¶ 61.

[92] *See* 47 U.S.C. § 303(r) (requiring the Commission to "[m]ake such rules and regulations and prescribe such restrictions and conditions, not inconsistent with law, … necessary to carry out the provisions of this chapter").

[93] *See* 47 C.F.R. § 25.261.

[94] The obligation of all qualifying NGSO FSS operators to pursue good-faith coordination under Section 25.261 within the capabilities of their existing systems is not a burden, especially where two previously proposed systems have chosen not to deploy and surrendered their spectrum and orbital resources for others to use. A third NGSO FSS authorization holder has reportedly ceased operations since the reply comments were filed. *See* Debra Werner, *Audacy Defaulted on Debt, Shut Doors in 2019*, SpaceNews, (Jan. 2, 2020), https://bit.ly/2Qn2Xfk ("*Audacy Defaulted on Debt, Shut Doors in 2019*"). While the Commission's records reflect no formal surrender of the company's authorization, that eventuality seems likely.

antennas and the spectrum sharing capabilities of authorized and proposed NGSO FSS systems.[95] The Commission's current framework relies on a case-by-case assessment balancing the public interest benefits of new entry against the operational impact, if any, on other NGSO FSS systems that are required to coordinate in good faith.[96]

B. Waiver of the Processing Round Rule Here Is Consistent With Longstanding Commission Precedent.

Waiver of the processing round rule in light of the circumstances and compelling public interest benefits set forth in the Application will give Amazon regulatory certainty that facilitates its investment of billions of dollars in its next-generation constellation, associated ground infrastructure, and other capabilities necessary to support a global broadband satellite system. Waiver will also allow Amazon to bring new services to U.S. consumers and other customers faster and more efficiently than would otherwise be possible if the Kuiper System were relegated to a new processing round with uncertain time frames. Waiver would not be "unprecedented," as some opponents state.[97] Over the past 15 years and as recently as a few months ago, the Commission has waived the processing round rules for parties situated similarly to Amazon.[98]

SpaceX relies on immaterial or irrelevant distinctions between the Kuiper System and the systems that previously received waiver in an effort to distinguish the Commission's precedent.[99] But the decisions in *Swarm*,[100] *DigitalGlobe*,[101] *Space Imaging*,[102] and *Northrop Grumman*[103] stand for the simple proposition that the Commission will waive the processing round rules when it concludes that a proposed system can coexist with other authorized systems and the operation

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[95] *See Amendment of the Commission's Space Station Licensing Rules and Policies*, First Report and Order and Further Notice of Proposed Rulemaking, 18 FCC Rcd 10760, ¶ 32 (2003) ("*2003 Licensing Reform Order*").

[96] *See NGSO FSS Order* ¶ 61.

[97] *See, e.g.*, SpaceX Reply at 14; SES/O3b Reply at 4.

[98] *See* Opposition at 7-8.

[99] SpaceX Reply at 14-17.

[100] *Swarm Technologies, Inc. Application for Authority to Deploy and Operate a Non-Voice, Non-Geostationary Lower Earth Orbit Satellite System in the Mobile-Satellite Services*, Memorandum Opinion, Order and Authorization, DA 19-1044, IBFS File No. SAT-LOA-20181221-00094, ¶ 17 (rel. Oct. 17, 2019) ("*Swarm Order*") (waiving the processing round requirement on the basis that Swarm will not preclude other systems from operating on the same spectrum).

[101] *DigitalGlobe, Inc., Modification of Authorization to Construct, Launch and Operate a Remote-Sensing Satellite System*, Order and Authorization, 20 FCC Rcd 15696, ¶ 8 (2005) (waiving the processing round requirement where no likelihood of interference exists).

[102] *Space Imaging,* at ¶¶ 10-11 (same).

[103] *Northrop Grumman Space & Mission Systems Corporation; Applications for Authority to Operate a Global Satellite System Employing Geostationary Satellite Orbit and Non-Geostationary Satellite Orbit Satellites in the Fixed-Satellite Service in the Ka-band and V-band*, Order and Authorization, 24 FCC Rcd 2330, ¶ 29 (2009) (same).

of the proposed system will not foreclose future access to the band. These are exactly the circumstances that the Kuiper System application presents.

The Commission's decision in *Swarm* is particularly instructive. There, the Commission allowed a new entrant to enter a band and waived the processing round rules because the entrant's spectrum-sharing capabilities would accommodate future satellite systems. The Commission's decision therefore not only allowed entry by Swarm, but also preserved the possibility of further entry by other competitors. The Commission expressly noted that its grant "does not confer on Swarm a higher status with respect to later authorized systems, unlike the first-come, first-served system specified in the Commission's rules for GSO-like satellite operations."[104] Instead, the Commission noted that future processing rounds would only prove necessary "depending on the number of any such applications and their ability to effectively share spectrum."[105] The logic of *Swarm* applies here given the Kuiper System's demonstrated ability to share spectrum and accommodate future Ka-band NGSO FSS systems.

Categorically subordinating the rights of later-in-time applicants in the context of the FCC processing-round framework would chill investment in NGSO FSS satellite technology. After the Commission released the *NGSO FSS Order*, OneWeb sought reconsideration and urged the Commission to adopt the ITU filing date as the standard by which earlier-filed systems receive priority over later ones.[106] As SpaceX explained in response, adopting a rule establishing subordinate access rights for later-in-time applicants would mean that "a later-filed NGSO operator intent on avoiding interference would be severely limited in the system it could design" and "would be unlikely to attract the investment necessary to achieve deployment of robust competitive satellite systems."[107] According to SpaceX, treating NGSO FSS applicants equally, instead of following a "'first-come, first-served regime in a potentially challenging sharing environment'" will result in "'more accommodation, more sharing, and ultimately, more competition.'"[108] Amazon agrees.

Furthermore, the Commission has long said it does not view filing date as a vehicle to confer priority over later applicants in other contexts. For more than two decades, the Commission has repeatedly rejected rules that would award the entire band to the first applicants

[104] *Swarm Order* ¶ 17.

[105] *Id.*

[106] Petition for Reconsideration of WorldVu Satellites Limited, IB Docket No. 16-408 (filed Jan. 17, 2018).

[107] Space Exploration Technologies Corp. Response to Petitions for Reconsideration, IB Docket No. 16-408, 8 (filed Feb. 20, 2018) ("SpaceX Recon Response"); *see also id* at 9-10 ("An operator that thinks all other NGSO systems must 'design around' its system is unlikely to agree to operational changes, even if these changes would lead to enhanced spectrum efficiency across all NGSO systems. Nor does such a presumption lead to incentives to innovate and invest in more spectrally-efficient technology or operational techniques.").

[108] *Id*. at 10 (quoting *NGSO FSS Order* ¶ 50).

that submitted their paper filings with applicable regulatory bodies, such as the ITU.[109] Such a first-in-time rule, as the Commission and other NGSO operators have observed, would promote speculation and warehousing; encourage inefficient system designs; reward anticompetitive behavior; and discourage good-faith coordination.[110] Like other Processing Round Participants, SpaceX has rejected first-in-time approaches in other contexts. As SpaceX said of the ITU's first-in-time rule in 2018, "adopting a simplistic system based on ITU filing date[] would encourage abuse, reduce certainty for prospective NGSO operators, and chill investment in the burgeoning NGSO sector that is focused on improving broadband access throughout the U.S. and internationally."[111]

The Commission also has long pursued a policy of promoting satellite competition.[112] Dampening economic incentives by imposing new barriers to satellite licensing would be particularly unwarranted in this case because several Processing Round Participants have failed

[109] *See, e.g.*, *NGSO FSS Order* ¶ 50 ("If the first priority system is not ultimately deployed, it could delay the provision of NGSO FSS broadband by lower-priority systems fearful of a hypothetical sharing environment. And it gives the highest priority system weaker incentives to accommodate competing NGSO FSS systems."); *2003 Licensing Reform Order* ¶ 22 (noting that the Commission's processing round framework seeks to avoid a scenario where "the first qualified applicant [would] request authority to operate in so much of the orbit-spectrum resource that additional market entry would be precluded").

[110] *See, e.g.*, *NGSO FSS Order* ¶ 50; Opposition and Response of SES Americom, Inc. and O3b Limited to Petitions for Reconsideration, IB Docket No. 16-408, at 3 (filed Feb. 20, 2018) ("Even OneWeb acknowledges that under its proposal 'the heavier coordination burden' would fall on applicants with lower ITU priority. Such disproportionate burdens would reward parties who fail to engage in good faith coordination and would hinder the deployment of multiple, competing NGSO systems, undermining achievement of the Commission's public interest objectives.").

[111] SpaceX Recon Response at 1; *see also* Opposition of Space Norway to Petition for Reconsideration, IB Docket No. 16-408, at 3 (filed Feb. 20, 2018) ("Relying on the date of receipt of satellite operators' ITU coordination requests would benefit only those who, perhaps speculatively, submitted an ITU filing at an early stage.").

[112] *See, e.g.*, *Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Space Stations to Provide Domestic & International Satellite Services in the United States, et al.*, Report and Order, 12 FCC Rcd 24094, ¶ 6 (1997) (liberalizing the entry requirements for foreign operators seeking U.S. market access and stating that "[the FCC's] continuing goal [is] to foster development of innovative satellite communications services for U.S. consumers through fair and vigorous competition among multiple service providers"); *Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band*, Report and Order, Memorandum Opinion, and Order and Further Notice of Proposed Rulemaking, 12 FCC Rcd 5754, ¶ 18 (1997) (finding that potential competitive harm to local radio broadcasters did not justify exclusion of satellite digital audio radio service); *Policies Regarding Detrimental Effects of Proposed New Broadcasting Stations on Existing Stations*, Report and Order, 3 FCC Rcd 638, ¶ 1 (1988) (abolishing the "*Carroll* doctrine," which considered the economic effect of granting a broadcast license on a rival broadcaster as relevant to the public-interest determination); *see also O3b Limited Request for Modification of U.S. Market Access for O3b Limited's Non-Geostationary Satellite Orbit System in the Fixed-Satellite Service and in the Mobile-Satellite Service*, Order and Declaratory Ruling, 33 FCC Rcd 5508, ¶ 23 (2018) (declaring it was not in the public interest to preclude other users in certain bands to preserve the existing operator's possible future deployment).

to deploy, and more withdrawals are possible.[113] The unserved and underserved communities that stand to benefit from additional NGSO FSS entry should not be forced to continue to wait to receive the benefits of more broadband competition and service, which is what may happen if the Commission accepts the unsupported arguments of commenters who want Amazon to wait for all Processing Round Participants to deploy or fail before moving forward.[114]

* * *

Amazon has provided a robust showing that the Kuiper System satisfies all of the Commission's requirements for expeditious grant of authority to operate on the same terms as approved NGSO FSS systems. Swift Commission action would serve the public interest by bringing high-capacity, low-latency broadband to tens of millions of unserved and underserved consumers, businesses, hospitals and schools in the United States and worldwide. Amazon remains committed to coordinating in good faith and ensuring that the Ka-band NGSO FSS operational environment allows both Processing Round Participants and future entrants to bring their important services to people everywhere.

Respectfully submitted,

/s/ Mariah Dodson Shuman
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Kuiper Systems LLC,
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[113] *See* Letter from Jose Albuquerque, Chief, Satellite Division, International Bureau, FCC, to Joseph C. Anders, LeoSat MA, Inc., IBFS File No. SAT-PDR-20161115-00112, at 1 (Oct. 31, 2019) (revoking LeoSat's grant of market access for failing to maintain its surety bond); Letter from Bruce A. Olcott, Counsel, The Boeing Company, to Jose Albuquerque, Chief, Satellite Division, International Bureau, FCC, IBFS File No. SAT-LOA-20161115-00109 (filed July 31, 2018) (withdrawing Boeing's application for authority for its Ka-band NGSO FSS system). In addition, Audacy Corporation has reportedly ceased operations. *See Audacy Defaulted on Debt, Shut Doors in 2019*. Although Processing Round Applicants refer to themselves as "first round" applicants, they are actually applicants from the third NGSO FSS processing round—none from the first two rounds were successful. *See Ka-Band Satellite Applications Accepted for Filing: Cut-off Established for Additional Applications*, Public Notice, Report No. SPB-20, DA 95-1689 (rel. July 28, 1995) (commencing the first Ka-band processing round); *Satellite Policy Branch Information: Satellite Applications Accepted for Filing in the Ka-Band Cut-Off Established for Additional Applications in the 28.35-28.6 GHz, 29.1-30 GHz, 17.7-18.8 GHz, & 19.3-20.2 GHz Frequency Bands*, Public Notice, 13 FCC Rcd 8020 (1997) (commencing the second Ka-band processing round).

[114] *See, e.g.*, Telesat Canada, Petition to Dismiss Without Prejudice or Hold in Abeyance, File No. SAT−LOA−20190704−00057, at 1 (filed Oct. 28, 2019) ("[B]efore the possibility of new entrants even is considered, processing round participants should have a period of time to develop their systems"); SES/O3b Petition at 15 ("If the Commission declines to dismiss the Application outright, it must at least defer any further consideration of the proposal until the Commission is ready to initiate a new Ka-band NGSO processing round. First, however, the Commission must allow legitimate participants in the November 2016 processing round to deploy their systems and determine on what basis any additional entry can be permitted.").